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GB 1477556 GB 1164003

(58) Field of search
F1W
F1D
Selected US specifications from IPC sub-classes F04B F15B

(54) **Hydraulic pulseless supply means**

(57) Hydraulic pulseless supply means comprises two hydraulic ram-pumps (1 and 2) arranged to deliver a combined pressurised output, and control means (40 to 49) for controlling the operation of the two ram-pumps such that the delivery strokes of the two ram-pumps overlap to produce a uniform, substantially pulseless pressurised output. The control means is operative to control valves (10,11,16,18) which determine the phasing of the delivery strokes. The valves are arranged so that during the delivery stroke of one ram-pump the flow of driving fluid thereto is reduced by passage through a restriction (12 or 13) and the other non-pump starts its delivery stroke in response to the application thereto of a full fow of driving fluid. A pump 6 provides the driving fluid.

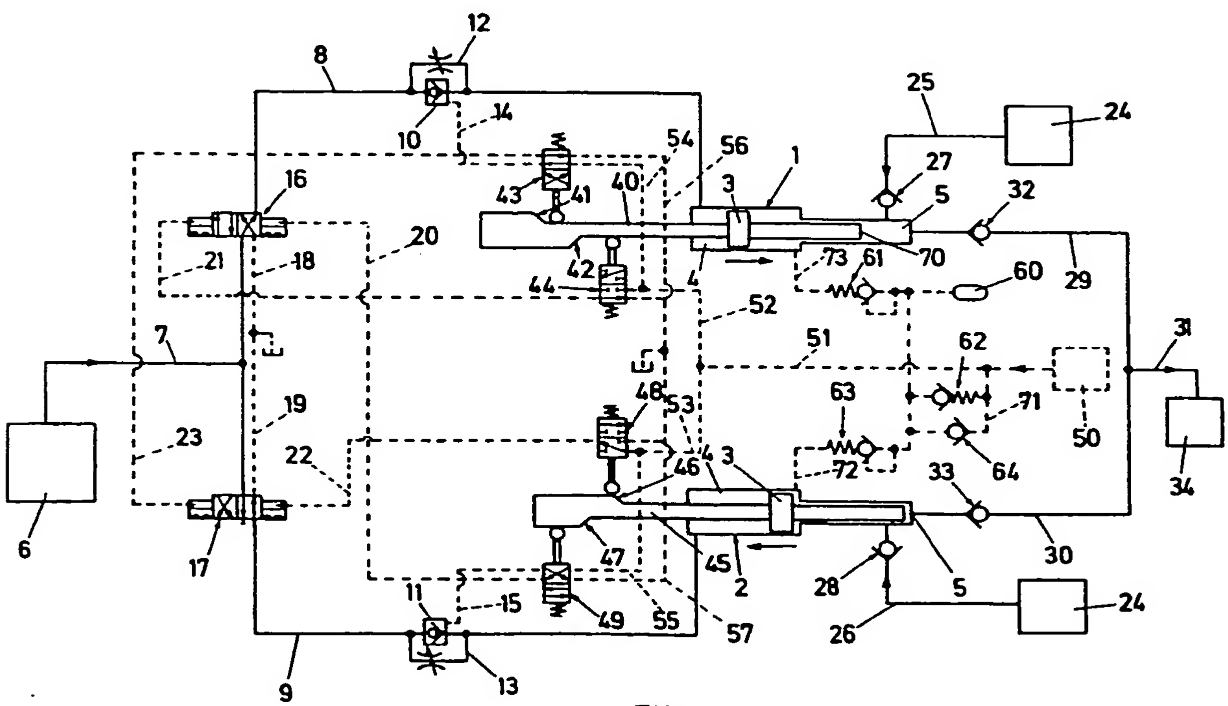

FIG. 1

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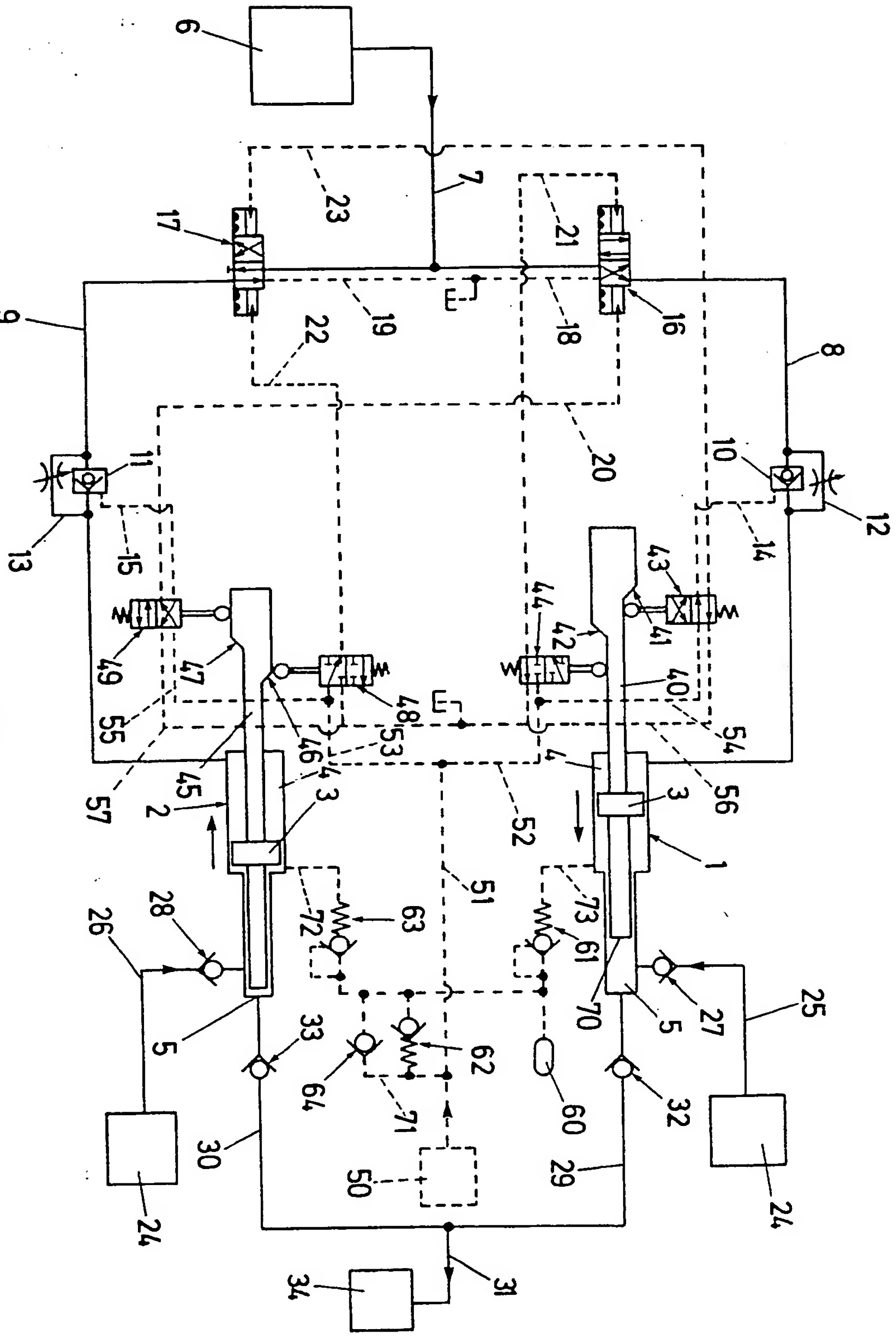
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FIG. 1

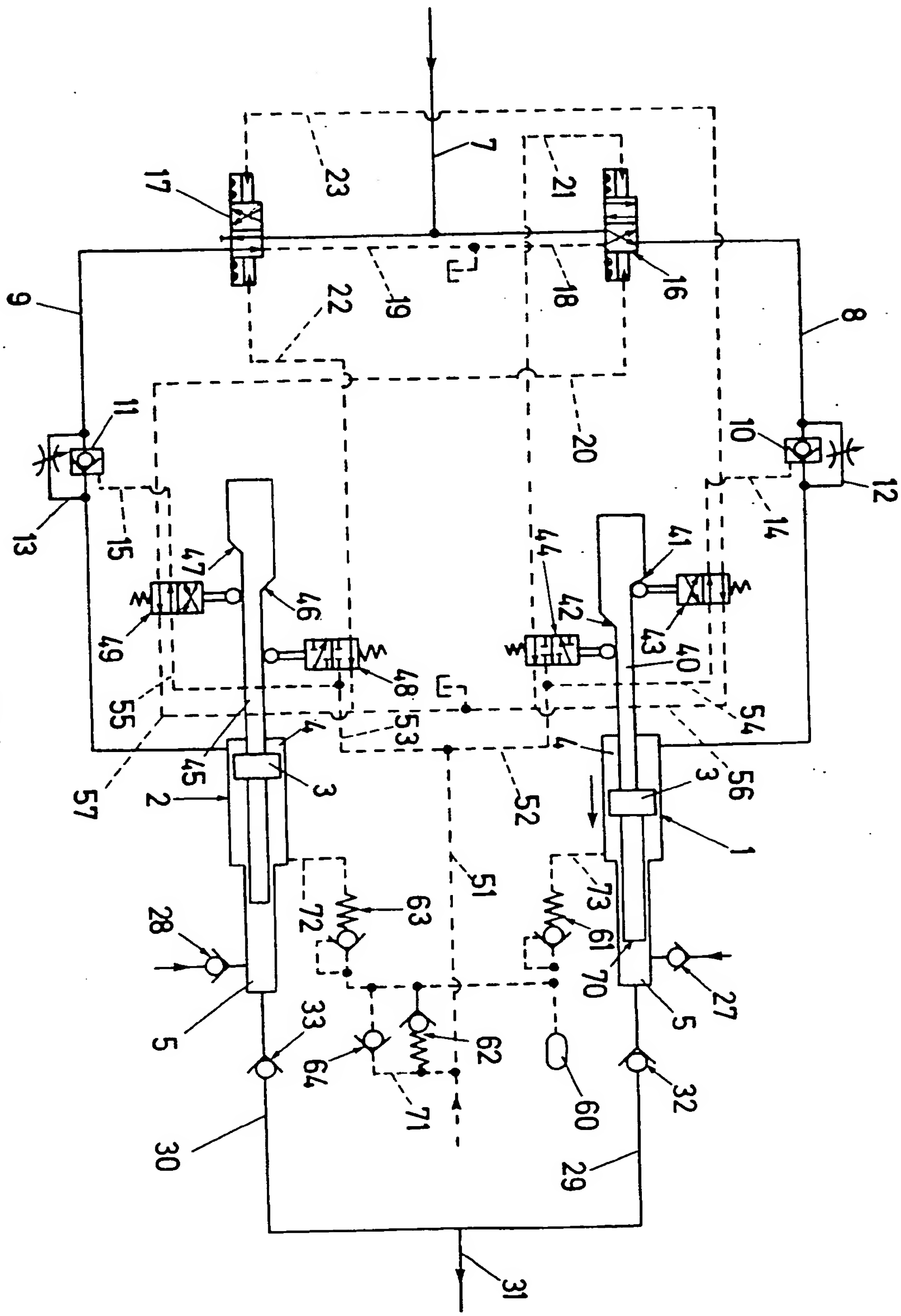
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FIG.2

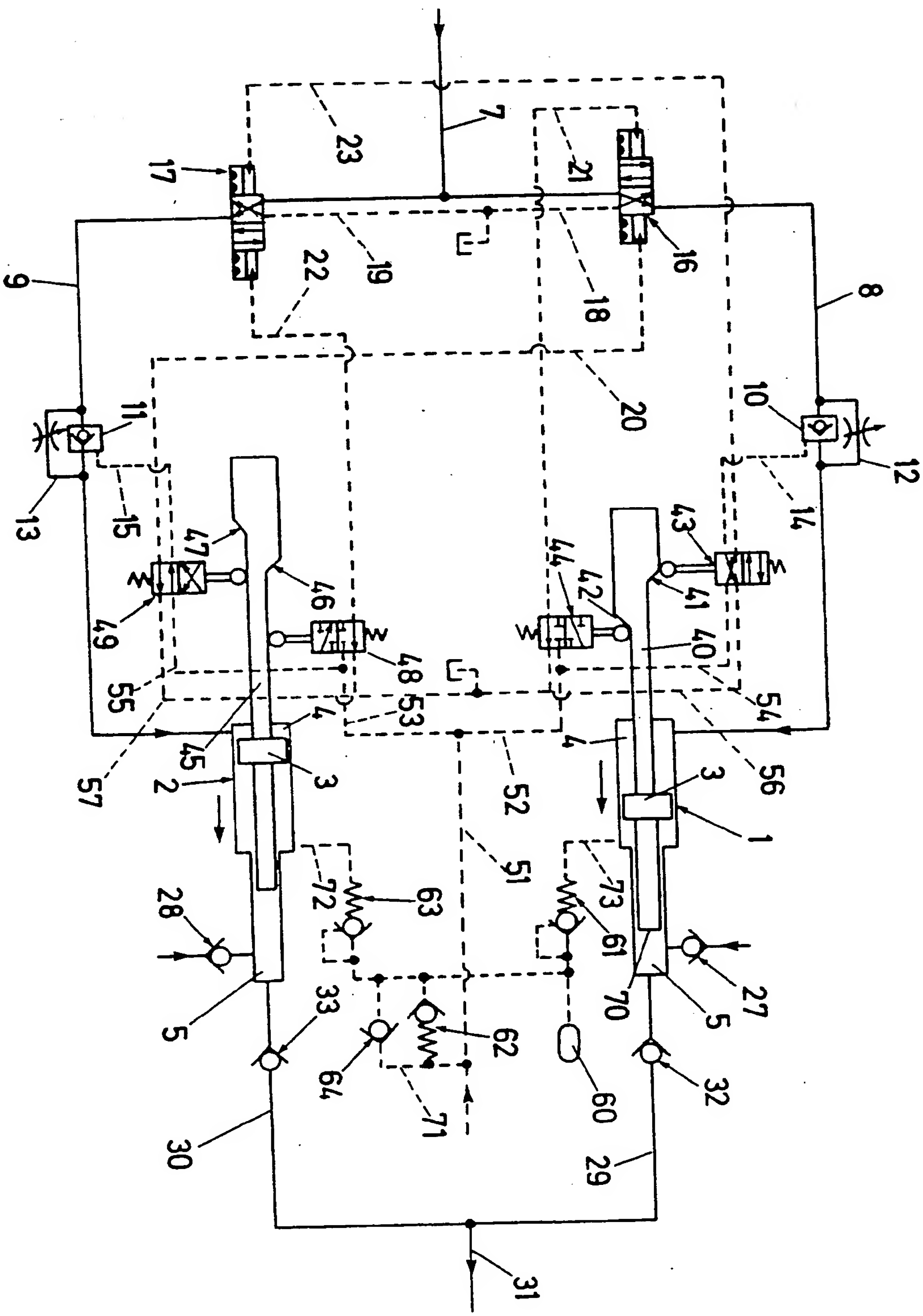

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FIG. 3

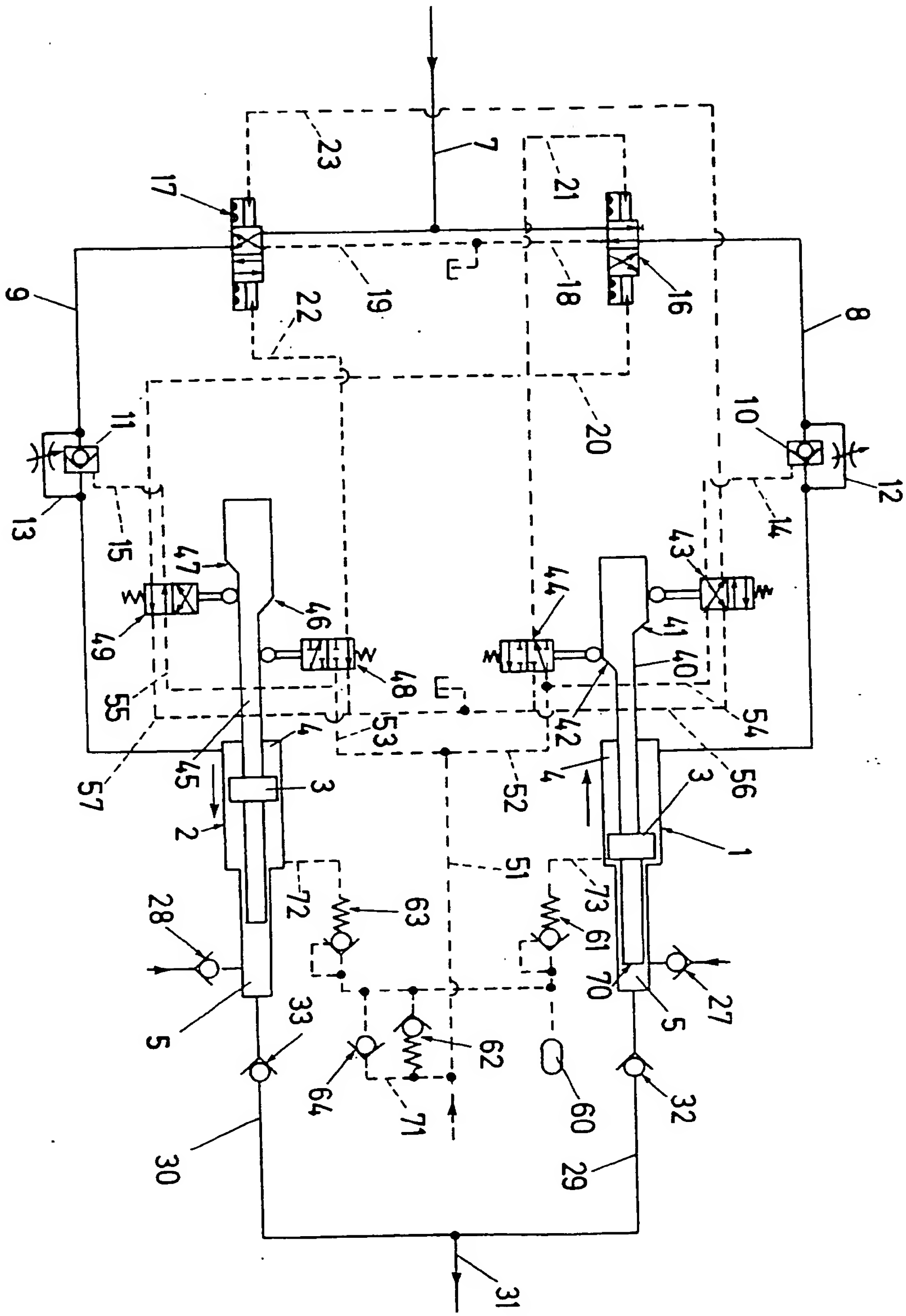
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FIG.4

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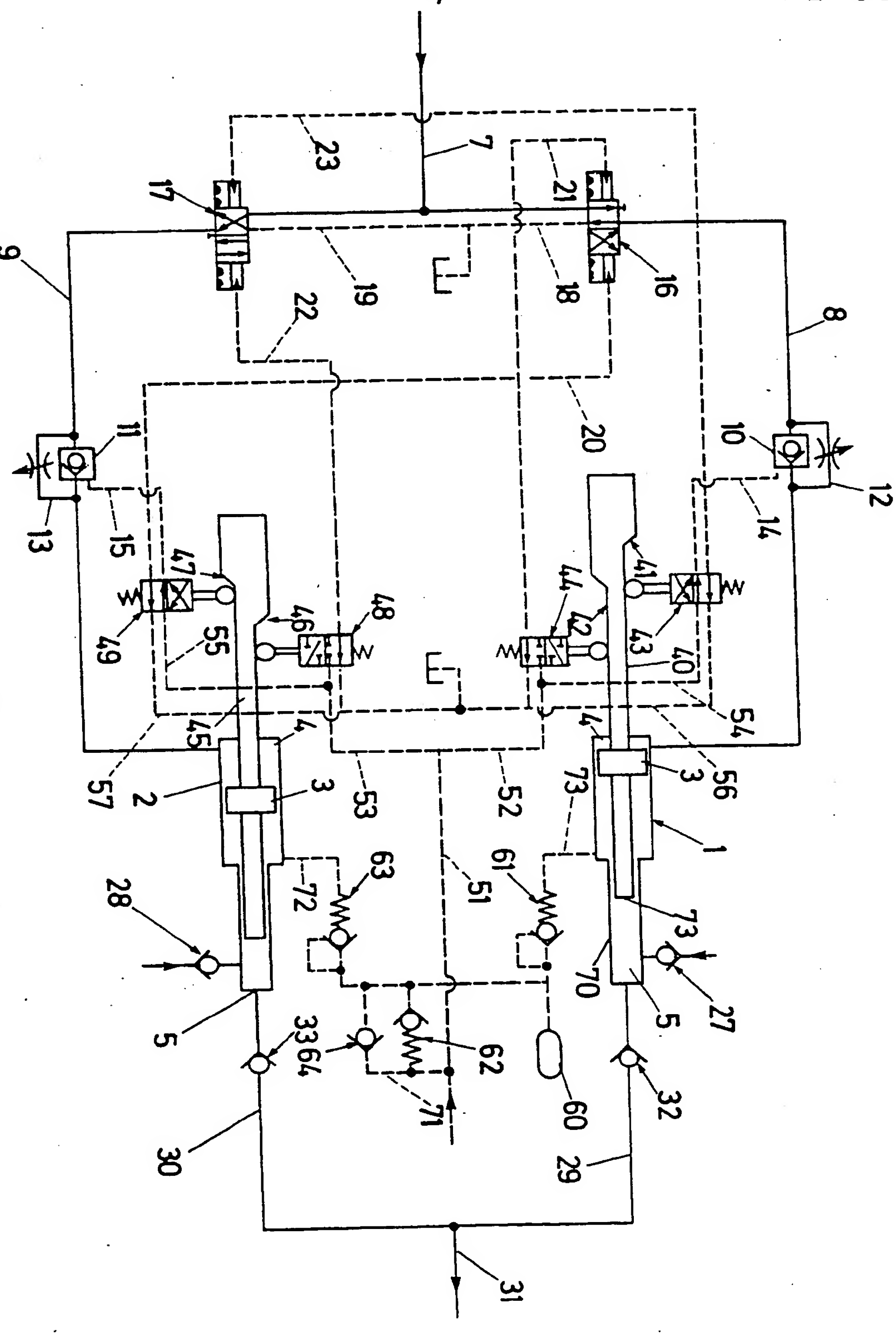

FIG.5

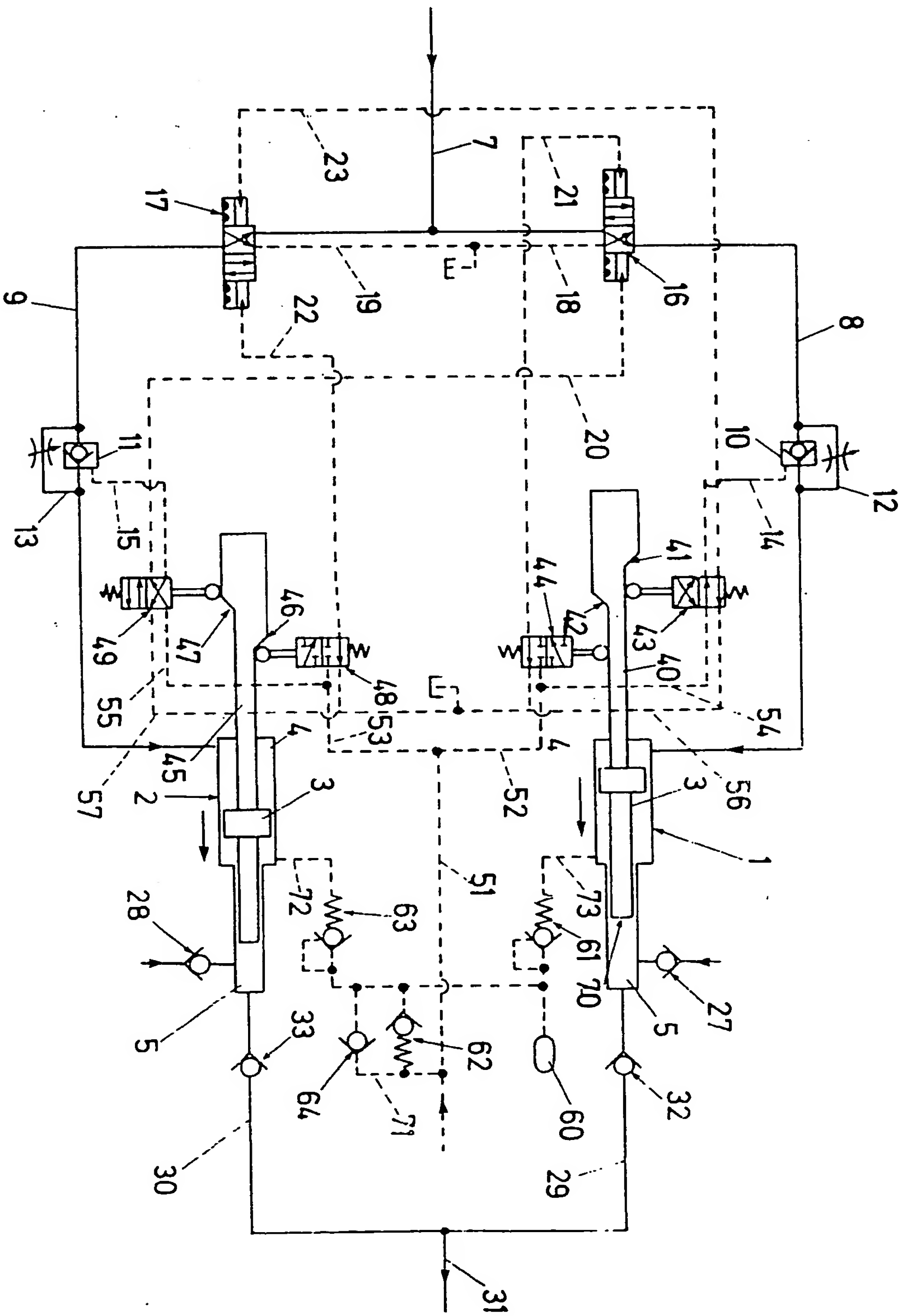
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FIG. 6

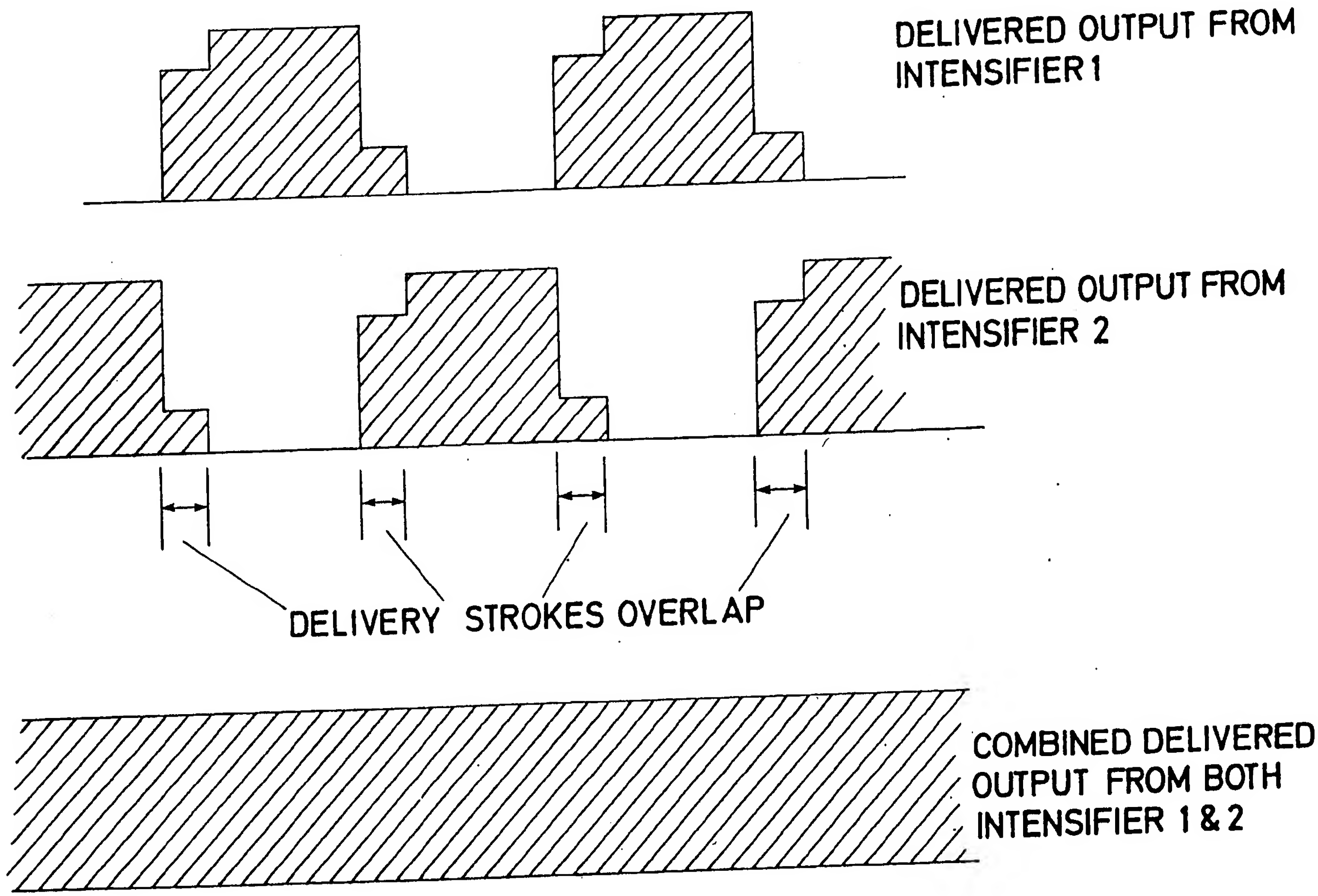
DELIVERED OUTPUT FROM
INTENSIFIER 1
DELIVERED OUTPUT FROM
INTENSIFIER 2
DELIVERY STROKES OVERLAP
COMBINED DELIVERED
OUTPUT FROM BOTH
INTENSIFIER 1 & 2

FIG.7

SPECIFICATION

Hydraulic pulseless supply means

This invention relates to hydraulic pulseless supply means.

In particular, although not exclusively, the present invention relates to phased hydraulic intensifier means comprising two single acting, phased intensifiers arranged to deliver a pulseless combined pressurised output.

One known phased intensifier means comprises two phased intensifiers the operations of which are controlled such that when one intensifier is just commencing its delivery stroke the other intensifier has just finished its delivery stroke and is about to commence its return stroke and vice versa. Unfortunately, the combined pressurised output of such means is not uniform but suffers from a phased effect due to a reduced pressure output towards the beginning and end of each delivery stroke. Thus, the combined pressure output exhibits are marked fall upon each change over.

An object of the present invention is to overcome or reduce the above mentioned problem by providing improved phased hydraulic intensifier means capable of delivering a substantially pulseless output.

According to the present invention hydraulic, pulseless supply means are provided comprising two hydraulic ram-pump devices arranged to deliver a combined pressurised output, and control means for controlling the operation of the two ram-pump devices such that the delivery strokes of the two ram-pump devices overlap to produce a uniform, substantially pulseless pressurised output.

Preferably, the hydraulic ram-pump devices constitute hydraulic intensifiers.

Conveniently, each hydraulic intensifier comprises a piston and cylinder arrangement, the piston having a relatively low pressure side and a relatively high pressure side.

Conveniently, the control means comprise cam activated valves, at least one cam being drivably connected to the piston of each intensifier.

Preferably, two cam formations are drivably connected to the piston of each intensifier, the cam formations being arranged to activate cam activated valves, respectively.

Preferably, the cam activated valves are included in a pilot control circut for controlling flow control valves in the main feed of pressurised fluid to the intensifiers.

Preferably, the combined output from the two intensifiers is fed to discharge nozzle means provided on a rock or mineral excavating machine.

By way of example, one embodiment of the present invention will be described with reference to the accompanying drawings, in which

Figure 1 is a block hydraulic circuit diagram of phased hydraulic intensifier means according to the present invention, the circuit being illustrated in one operational condition;

Figures 2 to 6 show the same block hydraulic circuit diagram as Figure 1, the circuit being illustrated in five further operational conditions; and

Figure 7 illustrates the delivered outputs from the two intensifiers.

The illustrated circuit shows two single acting hydraulic ram-pump, intensifiers 1 and 2 each having a relatively low pressure activating piston a cylinder arrangement 3, 4 and a relatively high pressure chamber 5. The relatively low pressure cylinders 4 are fed with hydraulic fluid from a relatively low pressure feed pump 6 via feed lines 7, 8, and 9, the lines 8 and 9 being provided with pilot operated non-return valves 10 and 11, respectively. The valves 10, 11 have full flow reverse capability and a restricted bypass facility through branch lines 12, 13 when no pilot signal is fed to the associated valve via pilot lines 14, 15. When a pilot signal is fed to one of the valves 10, 11, the valve has a full flow forward capability. Flow along each of the lines 8 and 9 is controlled by a two position, pilot operated, flow control valve 16 or 17, these valves are provided with detent means for retaining the valve in the desired position even if pilot pressure is lost. Return to tank lines 18 and 19 are provided from the valves. Operation of the flow control valves 16, 17 is controlled by pilot signals fed along pilot lines 20, 21 and 22, 23. The pilot control of valves 10, 11, 16 and 17 will be described later in this specification.

Fluid, for example water or other hydraulic fluid, is supplied to the two relatively high pressure chambers 5 from a common source 24 (shown twice in the drawings for the sake of convenience and which may comprise a mains supply or a feed pump). The fluid is supplied via feed lines 25, 26 provided with non-return valves 27, 28, respectively. The relatively high pressure phased output is discharged from the chambers 5 along lines 29, 30 to a common discharge line 31. The lines 29, 30 are provided with non-return valves 32, 33, respectively. The common discharge line 31 may feed a uniform, substantially pulseless discharge nozzle means 34 if the intensifier is provided on a rock or mineral excavating machine. Alternatively, the common discharge line 31 may constitute the feed line to further hydraulic means requiring a uniform, substantially pulseless supply.

Fixedly attached to the piston 3 of the intensifier 1 is an elongate member 40 provided with two cam formations 41 and 42 arranged to trigger two cam operated valves 43 and 44, respectively. Also, a similar elongate member 45 fixedly attached to the piston 3 of the second intensifier 2 provides a further two cam formations 46 and 47 arranged to trigger

two more cam operated valves 48 and 49, respectively. The valves 43, 44, 48 and 49 which are provided in the aforementioned pilot circuit are resiliently biassed against the actions of the cam formations.

Pressure fluid for the pilot circuit is supplied from a feed pump 50 via feed lines 51, 52, 53, 54 and 55. Return lines 56 and 57 also are provided in the pilot circuit. An accumulator 60 and various resiliently biassed relief valves 61, 62 and 63 are provided in the pilot circuit together with a non return valve 64, the two relief valves 61 and 63 are pilot operated which serve to maintain the intensifier positions during run down of the hydraulic pressure when shutting down the system, thus allowing restarting of the system to take place from the stopping position. During normal running operations the valves 61 and 63 are always open.

The operation of the intensifier means will now be described. Figure 1 shows the first stage of operation. As the valve 44 is not activated by cam formations 42 pilot pressure is cut off from pilot line 21 to the flow control valve 16. The pilot line 21 is vented to tank via return line 56. Also valve 43 is not activated by cam formation 41 so pilot pressure is fed to valve 10 via pilot line 14 to open valve 10 allowing full flow of drive fluid in either direction. With valve 43 in its non-activated spring returned position the pilot line 23 to flow control valve 17 is exhausted via return line 56.

The two cam operated valves 48 and 49 associated with the intensifier 2 are in their cam activated modes. Valve 49 has been activated by cam formation 47 allowing pilot pressure to be connected to pilot line 20 thereby causing relatively low pressure fluid to be fed from the source 6 via lines 7 and 8 and the open valve 10 (as forementioned) to the cylinder 4 of the intensifier 1. Activation of the valve 49 also exhausts pilot pressure from the line 15 allowing valve 11 to close. With the hydraulic circuit in this mode of operation the piston 3 of intensifier 1 is urged to move to the right as seen in the drawings compressing the liquid in the chamber 5 to a relatively high pressure (ie the delivery stroke). The increase in pressure of the liquid in chamber 5 compared to the pressure of liquid fed to chamber 4 is dependant upon the ratio of the working area of piston 3 to that of the piston rod end 70 acting on chamber 5. Also, as seen in Figure 1 the valve 48 has been activated by the cam formation 46 allowing pilot pressure to be fed from the pump 50 via feed lines 51, 53 to the pilot line 22 of flow control valve 17 which, thereby, is urged into its operational mode exhausting line 9 connected to the chamber 4 of intensifier 2. Consequently, the pilot pressure fed to the reverse side of piston 3 of intensifier 2 via pilot lines 71, 72 and valves 63, 64 moves the piston 3 to the left as seen in the drawing drawing liquid from the source 24 via line 26.

The chamber 4 of intensifier 1 will be receiving the full delivered output from the pump 6. Consequently, the piston 3 of intensifier 1 is moving at full speed (ie intensifier 1 is delivering 100% full flow). As the piston 3 of intensifier 2 is moving on its return stroke the total delivered from the two intensifiers 1 and 2 is 100% full flow.

The piston 3 of intensifier 2 continues moving on its return stroke until the cam activated valves 48, 49 disengage the cam formations 46, 47, repectively, and the valves are returned to their non-activated modes under the action of their resilient biasses. The operational mode of the hydraulic circuit is now as seen in Figure 2. The piston 3 of intensifier 2 moves further to the left as seen in the drawing until it reaches the end of its return stroke and comes to rest as seen in Figure 2.

Upon valve 48 being deactivated it vents pilot pressure from line 22 thereby exhausting the corresponding pilot signal from valve 17. However, the detent means provided on the valve 17 maintain the valve in the mode illustrated in Figure 2. Upon valve 49 being deactivated the valve 11 is opened by pilot pressure feed along line 15. Also, deactivation of valve 49 exhaust pilot pressure from line 20 and the corresponding pilot piston of valve 16. However, the valve 16 is maintained in the operational mode shown in Figure 2 by the action of the detent means.

The full output from pump 6 continues to be fed to the chamber 4 of intensifier 1 until the hydraulic circuit reaches a third operational position as illustrated in Figure 3.

As seen in Figure 3 the piston 3 of intensifier 1 has continued moving on its delivery stroke and the cam activated valve 43 has been activated by engagement with the cam formation 41. Activation of valve 43 feeds pilot pressure along line 23 to the corresponding pilot of valve 17 thereby changing the operation mode of the valve 17 to that shown in Figure 3. Changing the operational mode of valve 17 caused pressurised fluid to be fed from the main feed pump 6 along line 9 to the chamber 4 of intensifier 2 thereby starting the piston 3 of intensifier 2 to start its delivery stroke. Also, activation of valve 43 exhausted pilot pressure along line 14 thereby closing valve 10. However, a reduced flow of pressurised fluid from pump 6 still is fed to the chamber 4 of intensifier 1 via the bypass 12. The setting of the bypass 12 is such that 25% of full flow is fed to the chamber 4 of intensifier 1 and 75% of full flow is fed to the chamber 4 of intensifier 2. Thus, towards the end of the delivery stroke of intensifier 1 the delivery strokes of the two intensifiers overlap. Consequently, the total delivered flow from both intensifiers is 100% full flow. The pilot pressure on the non-working side of the

piston 3 of both intensifiers is controlled by relief valve 62.

The piston 3 of intensifier 1 continues moving on its delivery stroke with 25% of full flow delivery until the cam activated valve 44 is activated by engagement with the cam formation 42. The operational position of the hydraulic circuit now is as shown in Figure 4. Activation of valve 44 sends pilot pressure along 21 to change the operational mode of valve 16, thereby completely cutting off the supply of pressurised fluid to the chamber 4 of intensifier 1. By this time the piston 3 of intensifier 1 has reached the end of its delivery stroke and is brought to rest. The chamber 4 of intensifier 1 is connected to exhaust via valve 16 and the piston 3 is urged on its return stroke by the pilot pressure in lines 71, 73, a new charge of liquid being drawn into the chamber 5 from the source 24. Upon valve 16 changing its operational mode to cut off the supply of pressurised fluid to the intensifier 1 the full 100% flow is delivered to the chamber 4 of intensifier 2. Consequently, intensifier 2 now delivers 100% full flow. Hence the total flow from both intensifiers is 100% full flow.

With the intensifier 2 delivering 100% full flow, the piston 3 of intensifier 1 continues its return stroke under the action of pilot pressure and both cam operated valves 43 and 44 disengage their corresponding cam formations 41 and 42 and are urged to their deactivated modes by the resilient biasses. The operational position of the hydraulic circuit now is as shown in Figure 5. Deactivation of valve 44 exhausts pilot line 21. However, flow control valve 16 remains in the same operational mode under the action of its detent means. Deactivation of valve 43 feeds pilot pressure along line 14 to open valve 10. Also, pilot pressure is exhausted from line 23 to valve 17 which is retained in the same operational mode under the action of its detent means. Consequently, pressurised fluid continues to be fed to chamber 4 of intensifier 2 at the full rate and intensifier 2 delivers 100% of full flow. As piston 3 of intensifier 1 is at rest in Figure 5 the total flow delivered from both intensifiers is 100% full flow.

The intensifier 2 continues to deliver 100% of full flow with the piston 3 moving on its delivery stroke until the operational position of the hydraulic circuit reaches that shown in Figure 6. The valve 49 engages the cam formation 47 and is moved into its activated mode under the action of the cam engagement. Pilot pressure is exhausted from pilot line 15 leading to valve 11. Consequently, valve 11 is closed and the only pressurised fluid fed to the chamber 4 of intensifier 2 is via the bypass 13 which is set to deliver 25% of full flow. Hence, the intensifier 2 now delivers 25% of full flow. Cam activation of the valve 49 also feeds pilot pressure along pilot line 20 to the valve 16 which thereby changes its operational mode to feed pressure fluid from the main feed pump 6 to the chamber 4 of intensifier 1. Thus, simultaneous to reducing the feed to intensifier 2 to 25% of full flow the feed is introduced to intensifier 1. As intensifier 2 is taken 25% of full flow from pump 6 only 75% of full flow is fed to intensifier 1. Thus, towards the end of the delivery stroke of intensifier 2 the delivery strokes of the two intensifiers overlap.

Consequently, when the operational position of the hydraulic circuit is as shown in Figure 6 the total delivery from the two intensifiers is 100% of full flow (ie 75% from intensifier 1 and 25% from intensifier 2).

The piston 3 of intensifier 2 continues its delivery stroke with 25% of full flow until the valve 48 is activated by engagement with the cam formation 46. The piston then is brought to rest and the operation position of the hydraulic circuit is as shown in Figure 1. The whole of the operational cycle then is repeated.

The delivered outputs from each of the two intensifiers 1 and 2 and the total combined output from the two intensifiers are illustrated in Figure 7.

By comparing the two separate delivered outputs it can be seen that two delivery strokes overlap as the intensifiers approach the ends of their delivery strokes. The reduction in output from the intensifier approaching the end of its delivery stroke is matched by the increase in the output from the intensifier just commening its delivery stroke. Hence, the combined output from the two intensifiers 1 and 2 shows a constant uniform, pulseless delivery.

In the embodiment of the invention the ram-pumps do not intensify the pressure output.

CLAIMS

1. Hydraulic pulseless supply means comprising two hydraulic ram-pump devices arranged to deliver a combined pressurised output, and control means for controlling the operation of the two ram-pump devices such that the delivery strokes of the two ram-pump devices overlap to produce a uniform, substantially pulseless pressurised output.

2. Means as claimed in claim 1, in which the hydraulic ram-pump devices constitute hydraulic intensifiers.

3. Means as claimed in claim 2, in which each hydraulic intensifier comprises a piston and cylinder arrangement, the piston having a relatively low pressure side and a relatively high pressure side.

4. Means as claimed in claim 3, in which the control means comprise cam activated valves, at least one cam being drivably connected to the piston of each intensifier.

5. Means as claimed in claim 4, in which two cam formations are drivably connected to

the piston of each intensifier, the cam formations being arranged to activate cam activated valves, respectively.

6. Means as claimed in claim 5, in which the cam activated valves are included in a pilot control circuit for controlling flow control valves in the main feed of pressurised fluid to the intensifiers.

7. Means as claimed in one of the preceding claims 2 to 6, in which the combined output from the two intensifiers is fed to discharge nozzle means provided on a rock or mineral excavating machine.

8. Hydraulic pulseless supply means substantially as described herein and substantially as disclosed in the accompanying drawings.

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